spicuous element of the vegetation. Even so, there may be some obscure factor operating at this particular site which is absent from a multitude of other fallow fields where there would appear to be an equally good chance to harbor a similar collection of well established western weeds. Farmers have been using sheep manure from the woolen mills for years. Seeds of *Artemisia tridentata*, for example, must have been scattered far and wide in this manner; and yet here apparently is the first recorded occurrence of this species in eastern North America.

I am not disinclined to suspect that the "obscure factor" may have some connection with the aboriginal tenants of the field. At first sight, this may seem far-fetched, and yet rotted clam shells still exist in sufficient quantities to justify the local name Clam Shell Bluff. Probably of no more than mere coincidence is the fact that with the exception of sporadic specimens of a few of the species, the introduced plants are concentrated on precisely that part of the field where arrow heads formerly were abundant. In other words, they are now growing in the *close* vicinity of the very spots where the Indians erected their wigwams, and practically nowhere else.

Cambridge, Massachusetts

NOTES ON OEDOGONIUM AND BULBOCHAETE IN THE VICINITY OF WOODS HOLE, MASSACHUSETTS[1]

Chin-Chih Jao

(Plate 407)

It was hoped that the writer's paper on *Oedogonium* in the vicinity of Woods Hole, Massachusetts,[2] would be nearly complete for the region. Altogether, including both new and known forms, fifty-one species, varieties and forms were reported. During 1934, from June to August, the writer had an opportunity to continue his investigation of the freshwater algae in this region, with the result of finding some new plants of this genus, or unreported stations for fruiting *Oedogonia*, which were not included in the writer's first paper. These are listed in the first part of this paper. In the course of the studies on *Oedogonium*, a number of well fruited Bulbochaetes were identified. These plants are rather common around Woods Hole, but only a few species

[1] Papers from the Department of Botany and Herbarium of the University of Michigan, No. 505.

[2] Rhodora, Vol. 36, No. 426, P. 197–214, Pl. 286–288, June, 1934.

are represented in the writer's collections, of which *Bulbochaete Fuberae* Collins and *B. Brebissonii* Kuetzing are most common. The second part of this paper is a preliminary report dealing with *Bulbochaete* as collected at Woods Hole and vicinity, Barnstable County, Massachusetts, mostly in the summer seasons from 1932 to 1934.

The materials were mostly collected by the writer and Miss H. T. Croasdale; the writer wishes to thank her for her kindness in permitting the study of her samples. This study was made at the Marine Biological Laboratory, Woods Hole and in the Botanical Laboratories of the University of Michigan, under the direction of Professor Wm. R. Taylor, to whom the author is deeply grateful for help and valuable advice.

I. OEDOGONIUM

1. OEDOGONIUM CONCATENATUM (Hassall) Wittrock. "Beede's Oscillatoria Pond," North Falmouth, July 31, 1934 (*Croasdale*). Very abundant, attached to water grasses.

2. OEDOGONIUM CRENULATOCOSTATUM Wittrock f. CYLINDRICUM Hansgirg. Long Pond, Falmouth, 1929; "West Wood Pond," North Falmouth, Aug. 4, 1934 (*Croasdale*).

3. OEDOGONIUM CRISPUM (Hassall) Wittrock var. GRACILESCENS Wittrock. "Scar Spring," a small spring near the west shore of Naushon Island, June 18, 1934 (*Jao and Croasdale*); "Pasque J" Pond, Pasque Island, June 25, 1934 (*Jao*); Long Pond, Falmouth, 1929.

4. OEDOGONIUM CRISPUM Wittrock var. URUGUAYENSE Magnus & Wille. "Pasque K" Pond, Pasque Island, June 26, 1934 (*Jao*).

5. OEDOGONIUM CROASDALEAE Jao. "Endicott Hollow," Endicott Road, in Woods Hole, Aug. 8, 1934 (*Croasdale*).

6. OEDOGONIUM CRYPTOSPORUM Wittrock. "Scar Spring," Naushon Island, June 18, 1934 (*Jao and Croasdale*).

7. OEDOGONIUM CRYPTOSPORUM Wittrock var. VULGARE Wittrock. "Sheep Pen Pond," Nonamesset Island, June 18, 1934 (*Jao and Croasdale*).

8. OEDOGONIUM ECHINOSPERMUM Al. Braun. The local plants have dwarf males on or near the suffultory cell, stipes 1- to 3-celled, lower stipes 10–13 μ diam., 25–32 μ long, upper stipes 9–12 μ diam., 19–27 μ long. Collected in a pond near South Yarmouth, July 21, 1932.

9. OEDOGONIUM HIANS Nordstedt & Hirn var. **megasporum**, var. nov. (FIGS. 1, 2). Oedogonium dioicum, nannandrium, idioandrosporum; oogoniis 1–7, subglobosis, operculatis circumscissione superiore apertis; oosporis globosis, raro subglobosis, transversum oogonia fere complentibus vel complentibus, membrana laevi et crassa; androsporangiis 1–3 (–?); cellulis suffultoriis tumidis; nannandribus subtiliter curvatis, in cellulis suffultoriis sedentibus;

antheridiis exterioribus; cellulis vegetativis subtiliter capitellatis; cellula basali tumida; cellula terminali obtusa.

Cell. veg.	11–19 μ diam.,	64–102 μ long.
Oogonia	45–55 μ diam.,	48– 83 μ long.
Oosporae	44–48 μ diam.,	44– 58 μ long.
Cell. suffult.	35–38 μ diam.,	64– 74 μ long.
Androsporangia	19 μ diam.,	22– 26 μ long.
Nannand. stipes	11–13 μ diam.,	39– 45 μ long.
Antheridia	8–10 μ diam.,	6– 8 μ long.

Dioecious, nannandrous, idioandrosporous; oogonia 1–7, subglobose, operculate, division superior; oospore globose, rarely subglobose, nearly filling or filling the oogonium transversely, spore-wall smooth and thick; androsporangia 1–3(–?); suffultory cell swollen; dwarf male slightly curved, attached to the suffultory cell; antheridia exterior; vegetative cells slightly capitellate; basal cell tumid; terminal cell obtuse.

Long Island Pond, Falmouth, July, 1934 (*Croasdale*). Filaments scattered among many other filamentous algae. Type in C. C. Jao collections and Herb. Univ. Mich., *Woods Hole No. 136*.

These plants are characterized by their nannandrous habit, superior operculum, smooth spore-wall, swollen suffultory cell, and a tendency toward capitellate vegetative cells, showing that they are related to *Oe. hians* Nordstedt & Hirn. They differ, however, chiefly in having an idioandrosporous habit, a greater size, frequently long seriate oogonial chains, and the oospore usually not quite filling the oogonium.

10. Oedogonium oelandicum Wittrock & Hirn var. novae-angliae Jao. "Pasque J" Pond, Pasque Island, June 25, 1934 (*Jao*); "Endicott Hollow," Endicott Road, in Woods Hole, Aug. 8, 1934 (*Croasdale*).

11. Oedogonium platygynum Wittrock. "Sheep Pen Pond," Nonamesset Island, June 10, 1934 (*Jao and Croasdale*); "Deer Pond," Nonamesset Island, July 2, 1934 (*Croasdale*).

12. Oedogonium pratense Transeau. "Sheep Pen Pond," Nonamesset Island, June 19, 1934 (*Jao and Croasdale*).

14. Oedogonium reticulocostatum Jao. "Sheep Pen Pond," Nonamesset Island, June 19, 1934 (*Jao and Croasdale*); "Deer Pond," Nonamesset Island, July 2, 1934 (*Croasdale*).

14. **Oedogonium suborbiculare**, sp. nov. (Figs. 3, 4). Oedogonium dioicum, macrandrium; oogoniis 1- vel 10-continuis, subglobosis vel subellipsoidali-globosis, poro superiore apertis; oosporis globosis, interdum subglobosis, oogonia non vel fere complentibus, membrana triplici: episporio et endosporio laevibus; mesosporio scrobiculato, scrobiculationibus plus minusve concentricis et diametro variantibus; cellulis suffultoriis interdum tumidis parvis; antheridiis 1–3; spermatozoidiis binis, divisione horizontali; cellulis vegetativis plus

minusve capitellatis; cellula basali elongata; cellula terminali acuta, in filamentis femineis frequenter subtitutione oogonii nulla; filamentis masculis elongatis, ex cellulis vegetativis multis constantibus.

Cell. veg. plantae fem.	22–32 μ diam.,	112–218 μ long.
Cell. veg. plantae masc.	19–22 μ diam.,	130–210 μ long.
Oogonia (cum prolongatione)	64–74 μ diam.,	77–114 μ long.
Oosporae	54–67 μ diam.,	54– 67 μ long.
Antheridia	16–18 μ diam.,	13– 16 μ long.
Cell. basales	25–32 μ diam.,	166–180 μ long.
Cell. suffultoriae	22–38 μ diam.,	118–200 μ long.

Dioecious, macrandrous; oogonia 1–10, subglobose or ellipsoid-globose, pore superior; oospore globose, sometimes subglobose, not filling or nearly filling the oogonium, spore-wall of three layers: the outer and inner smooth, the median layer scrobiculate; scrobiculations more or less concentrically arranged and varying in diameter; suffultory cell sometimes slightly enlarged; antheridia 1–3; sperms 2, arising by horizontal division; vegetative cells more or less capitellate; basal cell elongate; terminal cell usually becoming an oogonium on fertile female filaments, but if sterile, acute; male filaments elongate, of many vegetative cells.

Lily Pond, Hatchville, between North and East Falmouth, Aug. 4, 1934 (*Croasdale*). Plants growing on water-grasses in company with *Bulbochaete Nordstedtii* Wittrock, etc. Type in C. C. Jao collections and Herb. Univ. Mich., *Woods Hole No. 130*.

This new species is distinguished from *Oe. Tiffanii* Ackley by the oogonium having a diameter always less than the length and by the larger vegetative cells, which are more or less capitellate in form. It also shows some characteristics of *Oe. scrobiculatum* Wittrock and *Oe. verrucosum* Hallas, but differs from the first chiefly in having a scrobiculate median spore-wall, from the second in having much better developed male filaments, not restricted to a holdfast cell and a few antheridial cells, and from both in having all cells of greater dimensions and vegetative cells more or less capitellate. The terminal oogonium of this new species generally extends into a long, acute process. The length of oogonia listed above includes the processes. If just the oogonia proper are considered, their length is 77–100 μ.

15. OEDOGONIUM UNDULATUM (Brebisson) Al. Braun f. SENEGALENSE (Nordstedt) Hirn (subforma). "Deer Pond," Nonamesset Island, July 2, 1934 (*Croasdale*).

II. BULBOCHAETE

1. BULBOCHAETE BREBISSONII Kuetzing. Furber Pond, Naushon Island, July 7, 1933 (*Jao*); "Wall Pond," Nonamesset Island, July 5 and 17, 1933 (*Jao and Croasdale*); Freshwater Pond, Nobska, Woods Hole, July 21, 1933 (*Jao*).

2. BULBOCHAETE ELATIOR Pringsheim. "Wood Pond," Ganset Road, in Woods Hole, June 23, 1933 (*Jao*).

3. BULBOCHAETE FURBERAE Collins. "Woods Pond," Ganset Road, in Woods Hole, June 23, 1933; Freshwater Pond, Nobska, Woods Hole, July 21, 1933 (*Jao*); "Wall Pond," Nonamesset Island, July 5, 1933 (*Jao and Croasdale*); Furber Pond, Naushon Island, July 7, 1933 (*Jao*); "Harper Pond," Whitman Road, Woods Hole, Aug. 27, 1933 (*Jao*).

4. BULBOCHAETE INTERMEDIA De Bary. "Sheep Pond," Cuttyhunk Island, 1922 (*Taylor*); July 27, 1933 (*Jao*).

5. BULBOCHAETE INTERMEDIA De Bary var. DEPRESSA Wittrock. "Sheep Pen Pond," Nonamesset Island, July 5, 1931 (*Croasdale*).

6. BULBOCHAETE MIRABILIS Wittrock. "On Fontinalis in a pond, Cuttyhunk Island, Gosnold, Massachusetts, July 11, 1907, in company with *B. intermedia* De Bary." Phycotheca Boreali-Americana, No. 1431.

7. BULBOCHAETE NORDSTEDTII Wittrock. Lily Pond, Hatchville, between North and East Falmouth, Aug. 4, 1934 (*Croasdale*).

8. BULBOCHAETE NORDSTEDTII Wittrock f. SUBERECTA Collins. Fawn Pond, Nonamesset Island, June 18, 1933 (*Croasdale*).

9. **Bulbochaete praereticulata**, sp. nov. (FIGS. 5–7). Bulbochaete dioica, nannandria, idioandrospora; oogoniis depresso-globosis vel raro depresso-oboviformi-globosis; patentibus, sub setis terminalibus; dissepimento cellularum suffultoriarum mediano; mesosporio reticulo-scrobiculato; androsporangiis 1–7; nannandribus quam oogoniis brevioribus, in oogoniis vel cellulis suffultoriis sedentibus; antheridiis exterioribus, stipite arcuato fere duplo longiore quam antheridio; cellulis vegetativi, praeter cellulas basales, androsporangiis et oogoniis spiraliter granulatis.

Cell. veg.	16–26 (–29)	μ diam.,	48–93 μ long.
Oogonia	54–58	μ diam.,	41–54 μ long.
Oosporae	52–56	μ diam.,	40–52 μ long.
Androsporangia	16–19	μ diam.,	6–10 μ long.
Nannand. stipes	9–10	μ diam.,	32 μ long.
Antheridia	9–10	μ diam.,	13–16 μ long.

Dioecious, nannandrous, idioandrosporous; oogonia depressed-globose or rarely depressed obovoid-globose, patent, below terminal seta; division of suffultory cell median; outer wall of the spore reticulate-scrobiculate; androsporangia 1–7; dwarf males shorter than the oogonia, developed on oogonia or on suffultory cells; antheridia interior; stipe about twice as long as the antheridium, curved; vegetative cells, except the basal cells, oogonia and androsporangia spirally granulate.

Shanks Pond, Falmouth, Aug. 4, 1934 (*Croasdale*). Type in C. C. Jao collections and Herb. Univ. Mich., *Woods Hole No. 133*.

Of the known species of this genus, only *Bulbochaete gigantea* Pringsheim has the reticulate outer spore-wall. This new species

has some similar characteristics, but differs distinctly in having acutely granulate vegetative cells, androsporangia and oogonia, and in the smaller dimensions of all parts.

10. BULBOCHAETE PYGMAEA Pringsheim & Wittrock var. **erecta,** var. nov. (FIGS. 8, 9). Bulbochaete dioica, nannandria, gynandrospora; filamentis abbreviatis, plerumque longitudine minus quam 10-cellularibus, simplicibus vel breviter ramosis, ramis 1- vel 2-cellularibus; oogoniis ellipsoideis, erectis, plerumque proximis ad cellulam basalem rarius terminalibus vel patentibus sub cellulis vegetativis vel setis; episporio longitudinaliter costato, costis fere 22, denticulatis, dentibus interse transverse costulatis; cellulis suffultoriis indivisis; androsporangiis sparsis, 1–2-cellularibus; nannandribus prope oogonia sedentibus; antheridiis exterioribus.

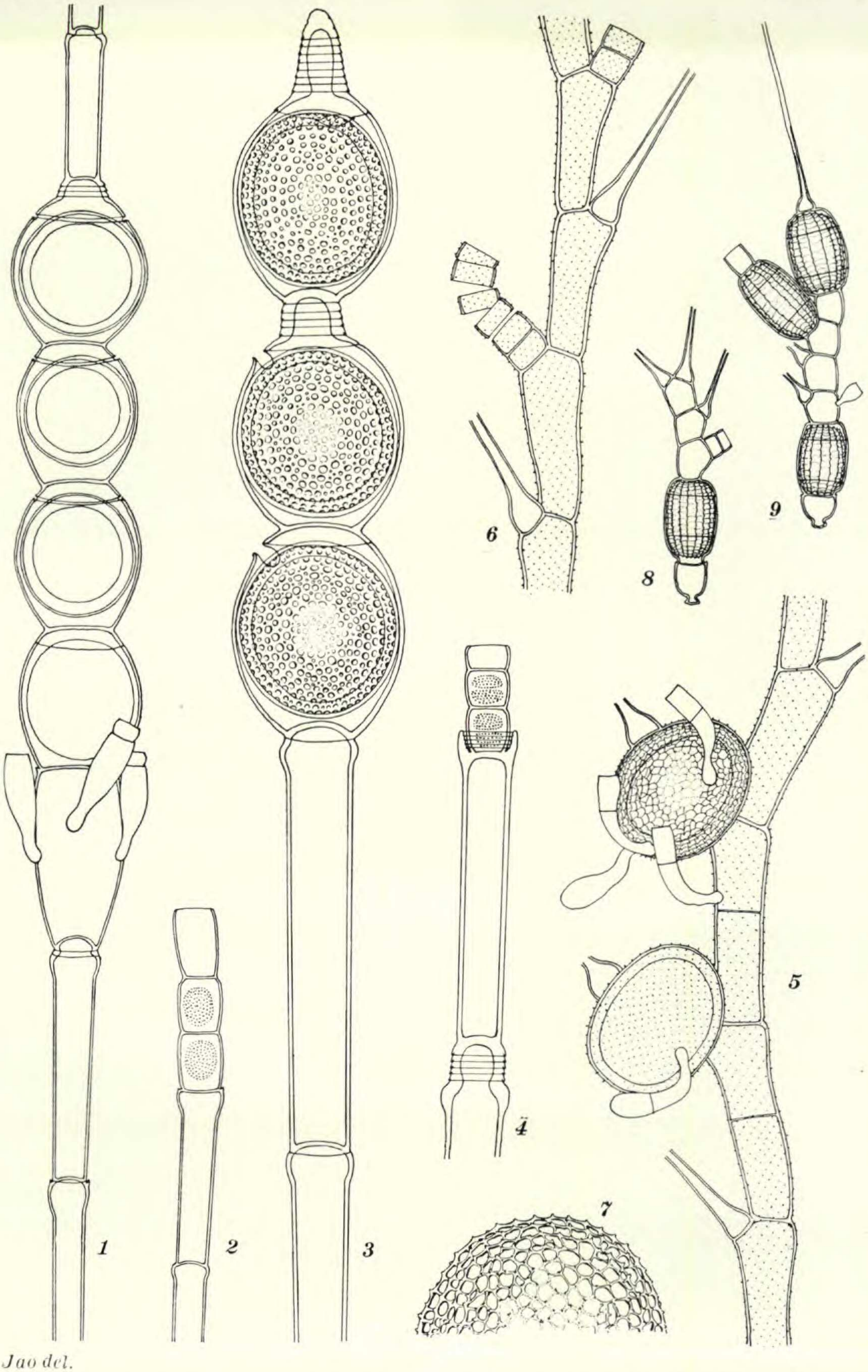
Cell. veg.	13–16 μ diam.,	10–16 μ long.
Oogonia	19–22 μ diam.,	29–38 μ long.
Oosporae	18–21 μ diam.,	28–35 μ long.
Androsporangia	10 μ diam.,	3 μ long.
Nannand. stipes	11 μ diam.,	16 μ long.
Cell. basales	13–16 μ diam.,	19–22 μ long.

Dioecious, nannandrous, gynandrosporous; filament short, usually less than ten cells long, unbranched or with 1- or 2-celled branches; oogonia ellipsoid, erect, usually next to the basal cell, very rarely terminal or patent below vegetative cells or setae; outer spore-wall longitudinally ribbed, ribs about 22 in number, dentate, the teeth united to each other by transverse ridges; suffultory cell without division; androsporangia scattered, 1–2; dwarf males near the oogonium; antheridium exterior.

Lily Pond, Hatchville, between North and East Falmouth, Aug. 4, 1934 (*Croasdale*). Epiphyte on *Bulbochaete Nordstedtii* Wittrock. Type in C. C. Jao collections and Her. Univ. Mich., *Woods Hole No. 130.*

This variety differs from the typical form in having the oogonia usually erect, in the smaller dimensions and in its very short filaments unbranched or with few very short branches. The author has compared this variety with typical *B. pygmaea* in F. S. Collins' specimens (Phycotheca Boreali-Americana No. 1683), and it appears quite different, especially in the position of the oogonia and the habit of the whole plant, for *B. pygmaea* has the oogonia regularly patent and the plant is longer and with more numerous branches.

11. BULBOCHAETE REPANDA Wittrock. Long Pond, Falmouth, July 15, 1900, Phycotheca Boreali-Americana, No. 814; "Sheep Pen Pond," Nonamesset Island, July 5, 1931 (*Croasdale*); Freshwater Pond, Nobska, Woods Hole, July 21, 1933 (*Jao*).



Jao del.

Figs. 1 and 2, Oedogonium hians var. megasporum; figs. 3 and 4, O. suborbiculare; figs. 5–7, Bulbochaete praereticulata; figs. 8 and 9, B. pygmaea var. erecta; figs. 1–6 and 8 and 9, × 303; fig. 7, × 652